

1. An optical switching/routing system comprising:  
a first router assembly, a second router assembly and a polarization converter assembly, each said assembly optically aligned with one another, said polarization converter assembly being optically interposed between said first router assembly and said second router assembly;

said first router assembly being capable of receiving a plurality of individual beams of electromagnetic radiation with polarization in a predetermined plane of polarization, said first router assembly having a predetermined orientation and including means defining a plurality of independently controlled segments for directing said plurality of individual beams of electromagnetic radiation from preselected locations along said segments for input into said polarization converter assembly;

said polarization converter assembly being capable of receiving said plurality of individual beams of electromagnetic radiation from preselected locations along said segments of said first router assembly, and of rotating said predetermined plane of polarization; and

said second router assembly being different in orientation from said predetermined orientation of said first router assembly, said second router assembly including means defining a plurality of independently controlled segments for receiving each of said individual beams from said polarization converter assembly and directing said individual beams for output from said second router assembly.

2. An optical switching/routing system as defined in claim 1 wherein said segments of said second router assembly are rotated 90 degrees with respect to the segments of said first router assembly.
3. An optical switching/routing system as defined in claim 1 wherein said first router assembly comprises at least one switchable diffractive element; and wherein said second router assembly comprises at least one switchable diffractive element.
4. An optical switching/routing system as defined in claim 1 further comprising:  
at least one steering grating optically disposed between said first router assembly and said polarization converter assembly.
5. An optical switching/routing system as defined in claim 1 further comprising:  
at least one steering grating optically disposed between said polarization converter assembly and said second router assembly.
6. An optical switching/routing system as defined in claim 1 wherein said polarization converter assembly comprises:  
a liquid crystal spatial light modulator.
7. An optical switching/routing system as defined in claim 1 wherein said polarization converter assembly comprises:

a half-wave retarder.

8. An optical switching/routing system comprising:
  - a polarization separating sub-system;  
said polarization separating sub-system being capable of separating an input optical beam into a first optical beam of a first polarization and a second optical beam of a second polarization, said second polarization being distinct from said first polarization, and emitting a first emitted optical beam of a third polarization and a second emitted optical beam of said third polarization, said emitted first and emitted second optical beams constituting an input channel of said third polarization;
  - a polarization recombining sub-system; and,
  - a grating based selectable switching/routing sub-system including at least one pixilated switchable component, said selectable switching and routing sub-system being interposed optically between said polarization separating sub-system and said polarization recombining sub-system; and;
  - said selectable switching/routing sub-system being capable of switching/routing said input channel to an output channel of a fourth polarization, said output channel constituting a pair of output beams of said fourth polarization;
  - said polarization recombining subsystem being capable of recombining said pair of output beams of said fourth polarization into a final output beam of combined polarization.

9. The optical switching/routing system of claim 8 wherein said polarization separating sub-system comprises a polarization splitter and a patterned polarization converter.
10. The optical switching/routing system of claim 8 wherein said polarization recombining sub-system comprises a patterned polarization converter and a polarization combiner.
11. The optical switching/routing system of claim 9 wherein said polarization splitter comprises a pair of polarization splitting gratings.
12. The optical system switching/routing of claim 10 wherein said polarization combiner comprises a pair of polarization combining gratings.
13. The optical switching/routing system of claim 9 wherein said third polarization comprises a same polarization as said first polarization.
14. The optical switching/routing system of claim 13 wherein

said polarization splitter is capable of separating said input beam into said first optical beam of said first polarization and said second optical beam of said second polarization; and,

wherein said patterned polarization converter comprises:  
a first region capable of receiving said first optical beam of said first polarization from the polarization splitter and capable of

emitting said first emitted optical beam of said first polarization; and,

a second region capable of receiving said second optical beam of the second polarization from the polarization splitter and capable of emitting said emitted second optical beam of said first polarization.

15. The optical switching/routing system of claim 10 wherein said third polarization comprises a same polarization as said first polarization and wherein said fourth polarization comprises a same polarization as said first polarization.

16. The optical switching/routing system of claim 15 wherein said patterned polarization converter comprises:  
a first region capable of receiving one of said pair of output beams of said first polarization from said selectable switching/routing sub-system and capable of emitting a first output optical beam of said first polarization into said polarization combiner; and,

a second region capable of receiving another one of said pair of output beams of said first polarization from said selectable switching/routing sub-system and capable of emitting a second output optical beam of said second polarization into said polarization combiner.

17. A polarization separating/combining system comprising:

a polarization converter comprising a first region, and, a second twisted nematic rotator region;

said first region being capable of receiving a first optical beam of a first polarization and being capable of emitting a first emitted optical beam of said first polarization; and,

said second twisted nematic rotator region being capable of receiving a second optical beam of a second polarization and emitting a second emitted optical beam of said first polarization.

18. The polarization separating/combining system of claim 17 further comprising:

a polarization beam-splitter capable of separating an input optical beam into said first optical beam of said first polarization and said second optical beam of said second polarization.

19. The polarization separating/combining system of claim 17 further comprising:

a polarization combiner capable of combining said first emitted optical beam of said first polarization and said second emitted optical beam of said second polarization into an output optical beam of combined polarization;

said polarization combiner being also capable of receiving said first emitted optical beam and said second emitted optical beam from said polarization converter.

20. A method for constructing a patterned polarization converter comprising the steps of:

constructing a receptacle to contain an ultraviolet curable nematic material; said receptacle being constructed by the steps of:

coating an inner surface of a first substrate with a first alignment layer;

coating a lower surface of a second substrate with a second alignment layer;

placing spacers so that said lower surface of the second substrate is substantially parallel, oppositely spaced apart from and facing the inner surface of the first substrate;

filling the receptacle with the ultraviolet curable nematic material;

annealing the filled receptacle until a desired configuration of the nematic material, dictated by the first and second alignment layers, is achieved;

placing a mask in contact with the nematic material in the filled, annealed receptacle;

heating the nematic material to adjust the desired configuration;

expose the nematic material through the mask with ultraviolet radiation, the ultraviolet radiation curing the exposed nematic material, masked regions remain unexposed;

removing the mask;

heating the receptacle above a clearing temperature of the unexposed nematic material;

exposing the nematic material in the filled receptacle to ultraviolet radiation, the ultraviolet radiation curing the unexposed nematic material;

allowing the nematic material in the filled receptacle to return to room temperature.

21. The method of claim 20 wherein the step of filling the receptacle further comprises the step of utilizing capillary action to fill the cell.
22. The method of claim 20 wherein the spacers are placed on the first substrate and the step of filling the receptacle further comprises the steps of:
  - placing the nematic material on the first substrate;
  - heating the substrate and nematic material until the nematic material is liquid;
  - placing the second substrate on top of the liquid nematic material and the spacers.
23. The method of claim 20 wherein the spacers are placed on the first substrate and the step of filling the receptacle further comprises the steps of:
  - solvent casting the nematic material onto the first substrate;
  - placing the second substrate on top of the nematic material and the spacers.

24. A polarization separating/combining system comprising:
- a pair of polarization sensitive gratings;
- a first grating of said pair of polarization sensitive gratings, when operating in the separating mode, being capable of receiving an input beam of electromagnetic radiation and separating said input beam of electromagnetic radiation into a first separated beam of a first polarization and a second separated beam of a second polarization;
- a second grating of said pair of polarization sensitive gratings being optically aligned with said first grating to receive said first separated beam of a first polarization and said second separated beam of a second polarization and capable, when operating in the separating mode, of providing a first output beam of the first polarization and a second output beam of the second polarization; and,
- when said pair of polarization sensitive gratings operates in the combining mode, said second grating being capable of receiving as an input a first input beam of the first polarization and a second input beam of the second polarization; and, said first grating being capable of providing as an output an output beam of combined polarization.

25. The polarization separating/combining system of claim 24 wherein, when operating in the splitting mode, said first output beam of a first polarization and said second output beam of a second polarization propagate along substantially parallel directions; and,

wherein, when operating in the combining mode, said first input beam of a first polarization and said second input beam of a second polarization propagate along substantially parallel directions.

26. The polarization separating /combining system of claim 24 further comprising:

a patterned polarization converter optically aligned to receive said first output beam of a first polarization and said second output beam of a second polarization from said second grating of said pair of polarization sensitive gratings.

27. The polarization separating /combining system of claim 24 further comprising:

a patterned polarization converter being capable of emitting a first emitted beam of a first polarization and a second emitted beam of a second polarization and being optically aligned to provide said first emitted beam and said second emitted beam to said second grating of said pair of polarization sensitive gratings.

28. The polarization separating/combining system of claim 26 wherein said patterned polarization converter is capable of emitting a first emitted beam of a third polarization and a second emitted beam of the third polarization.

29. The polarization separating /combining system of claim 26 wherein said patterned polarization converter comprises a polymerized twisted nematic rotator.

30. The polarization separating /combining system of claim  
27 wherein said patterned polarization converter comprises  
a polymerized twisted nematic rotator.